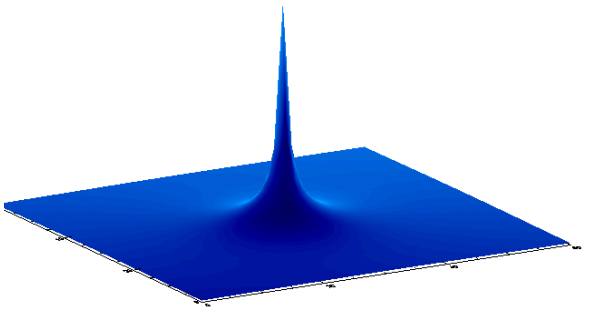
Cusp at the heart of NGC1068

D. Rouan, L. Grosset, D. Gratadour
LESIA, Observatoire de Paris

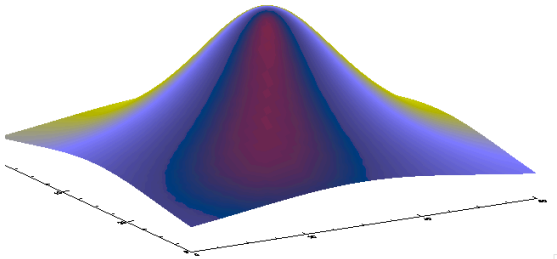
Cusp/Core problem

Dark matter density profile at centre of galaxies:

• Cosmological simulations :
steep power-law (cusp)



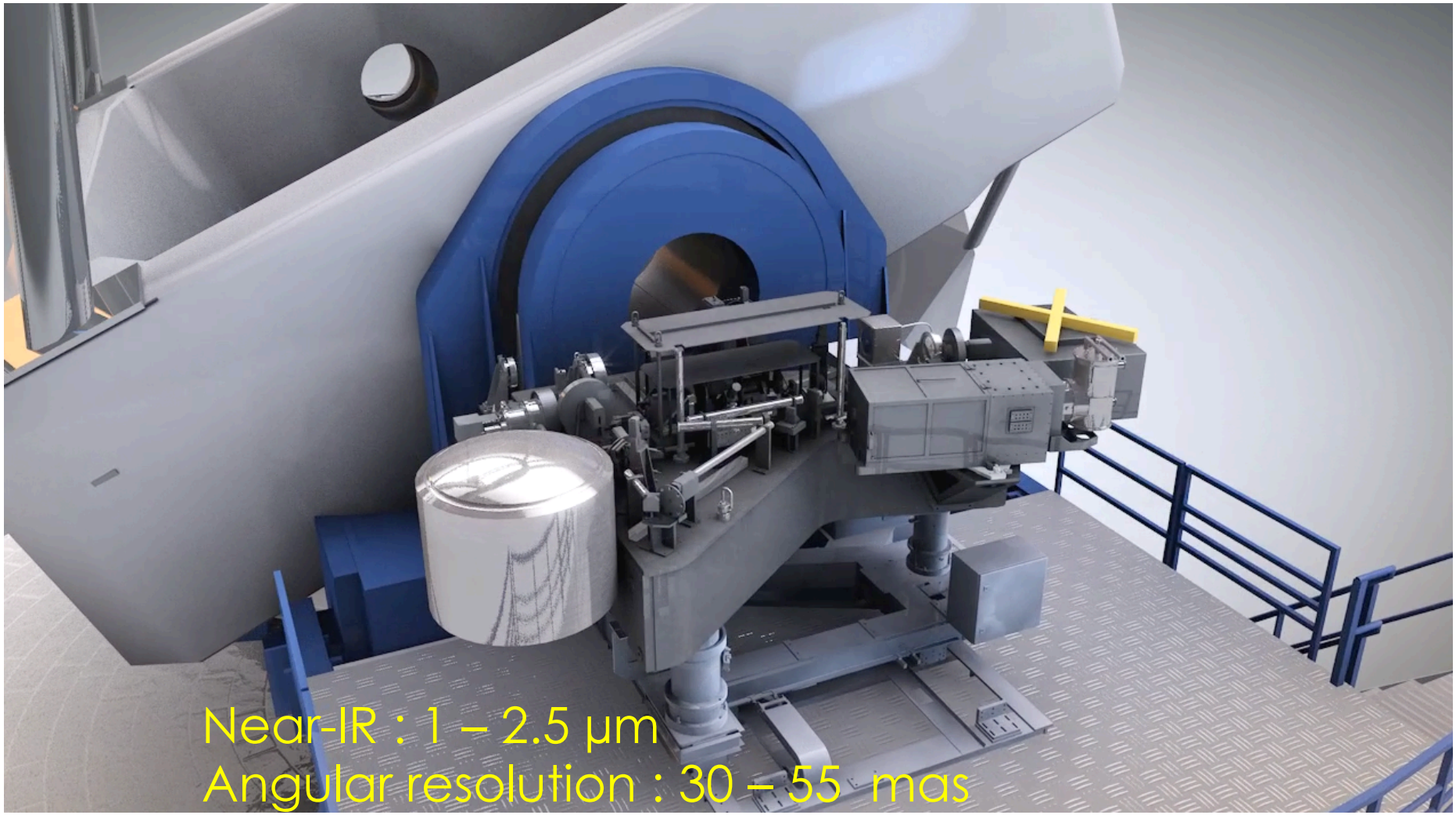
• Observations of low surface brightness disk and gas-rich dwarves :
constant density (core)



Controversy still alive :

• Mechanisms could transform cusps into cores : supernova feedback (Pontzen+18 & talk by J. Freundlich), self-interaction,…
• Bias in data analysis (triaxiality, …)

Near-IR Imaging with SPHERE

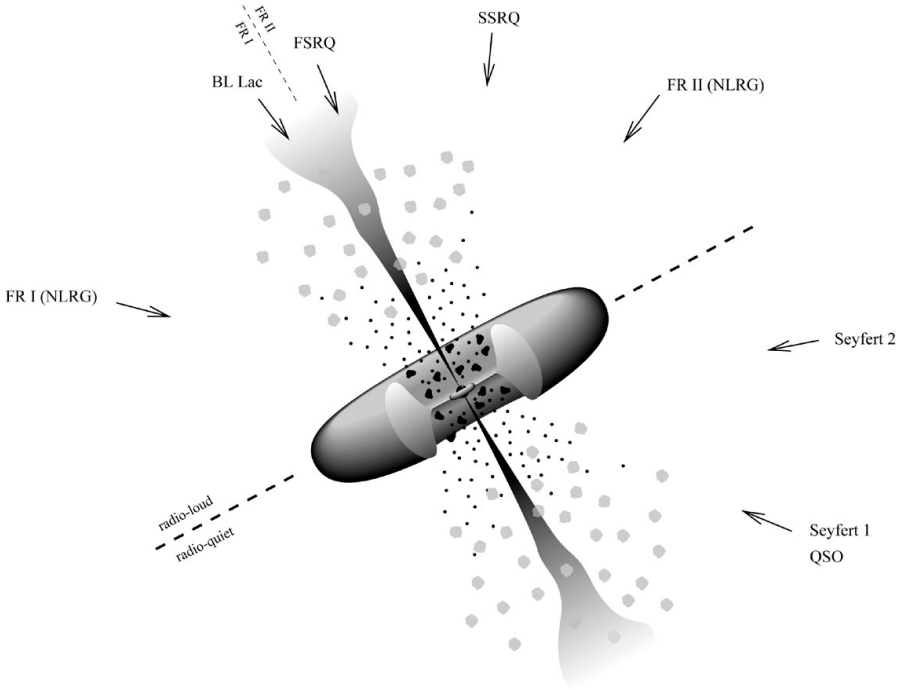


NGC 1068 = M 77

Archetype of type 2 Seyfert galaxy

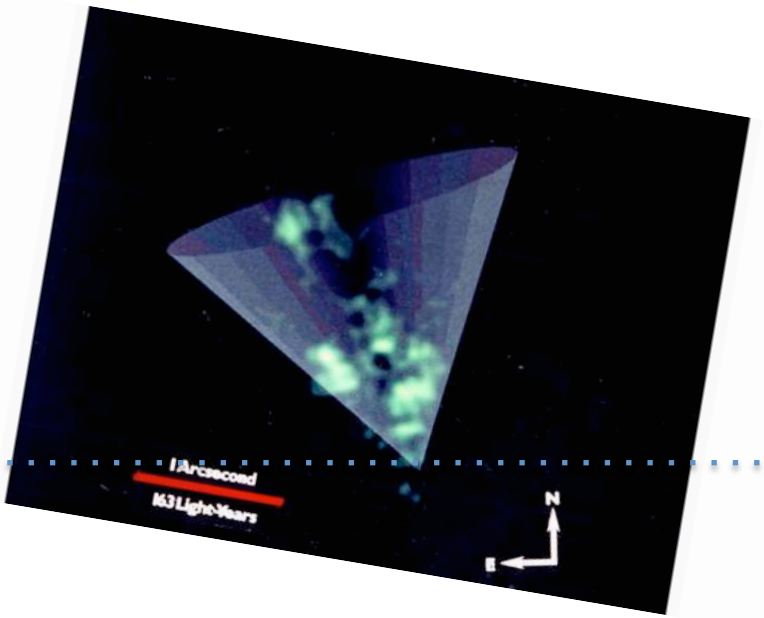
Nearby: 15 Mpc (1'' = 70 pc).

Well studied at all l

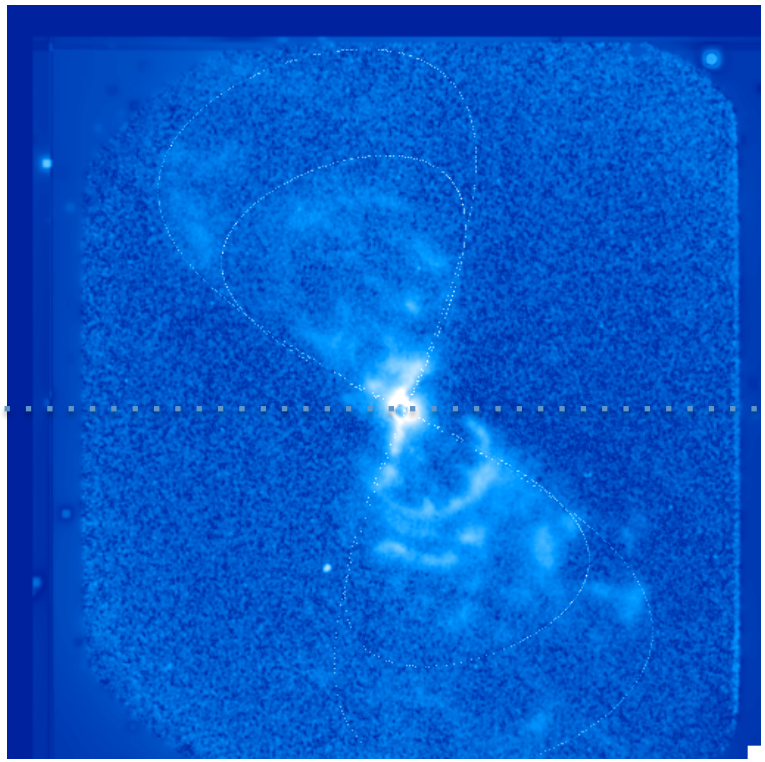


Unified Model of AGNs
(Antonucci & Miller 85)

Ionisation cone

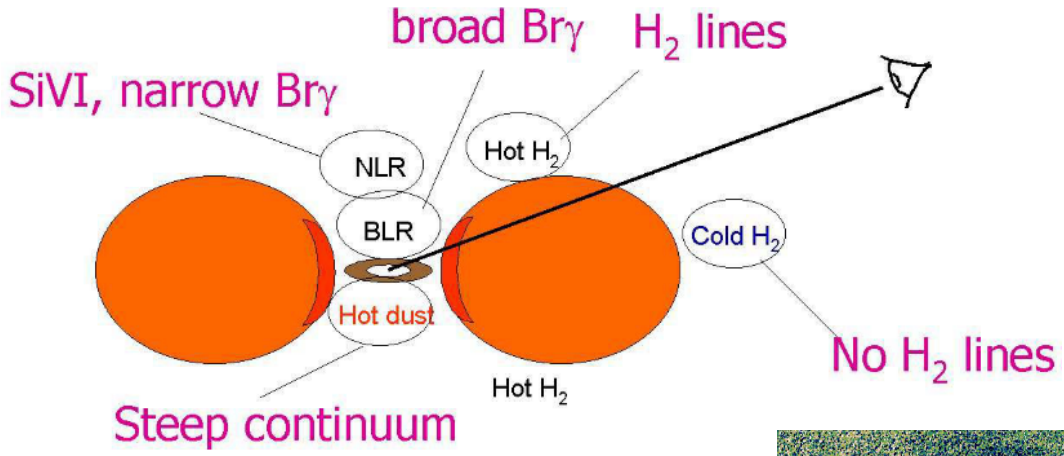


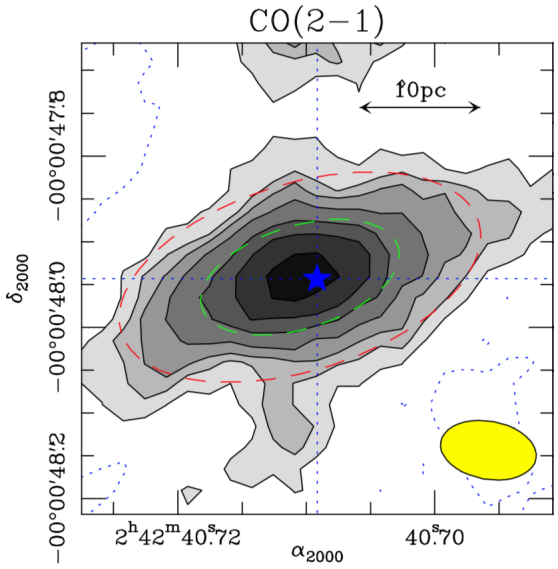
HST [OIII]
(Capetti+ 95)



SPHERE K_s
(Gratadour+15)

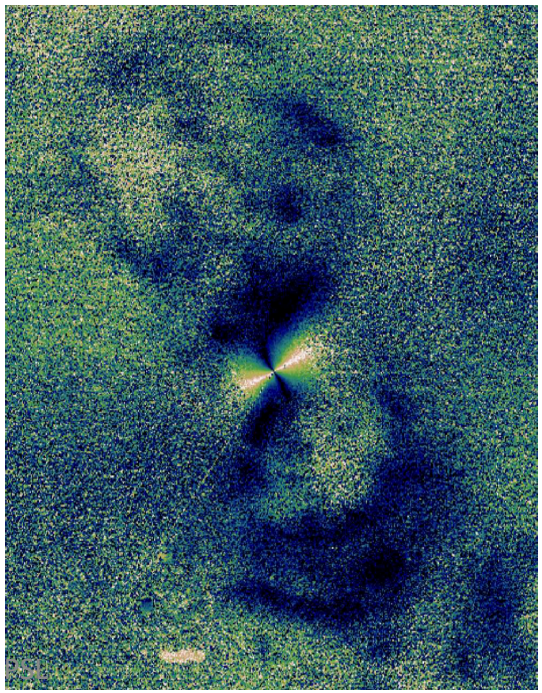
Molecular/dust torus: 1-30 pc



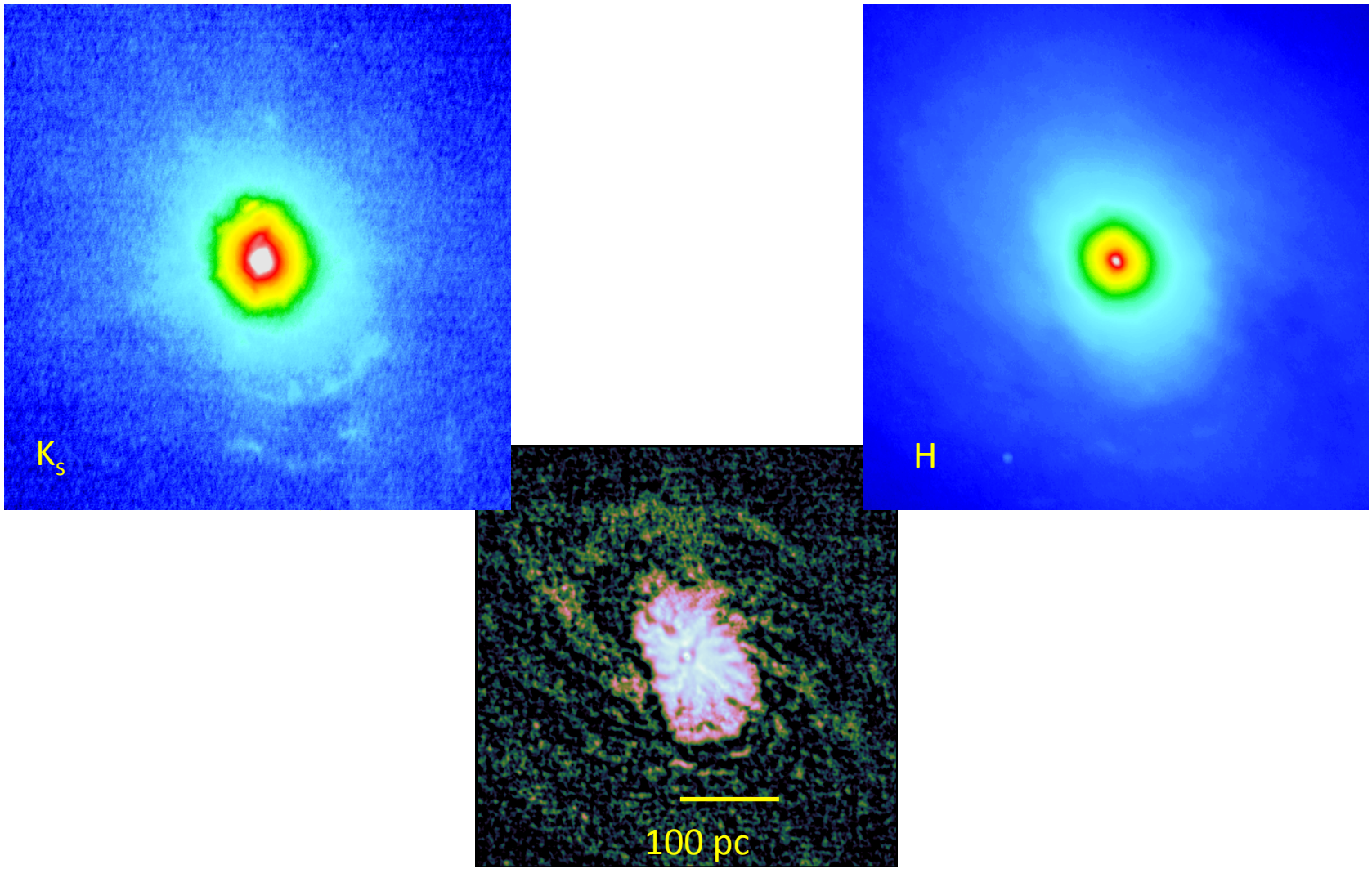


ALMA CO
(Garcia-Burillo+19)

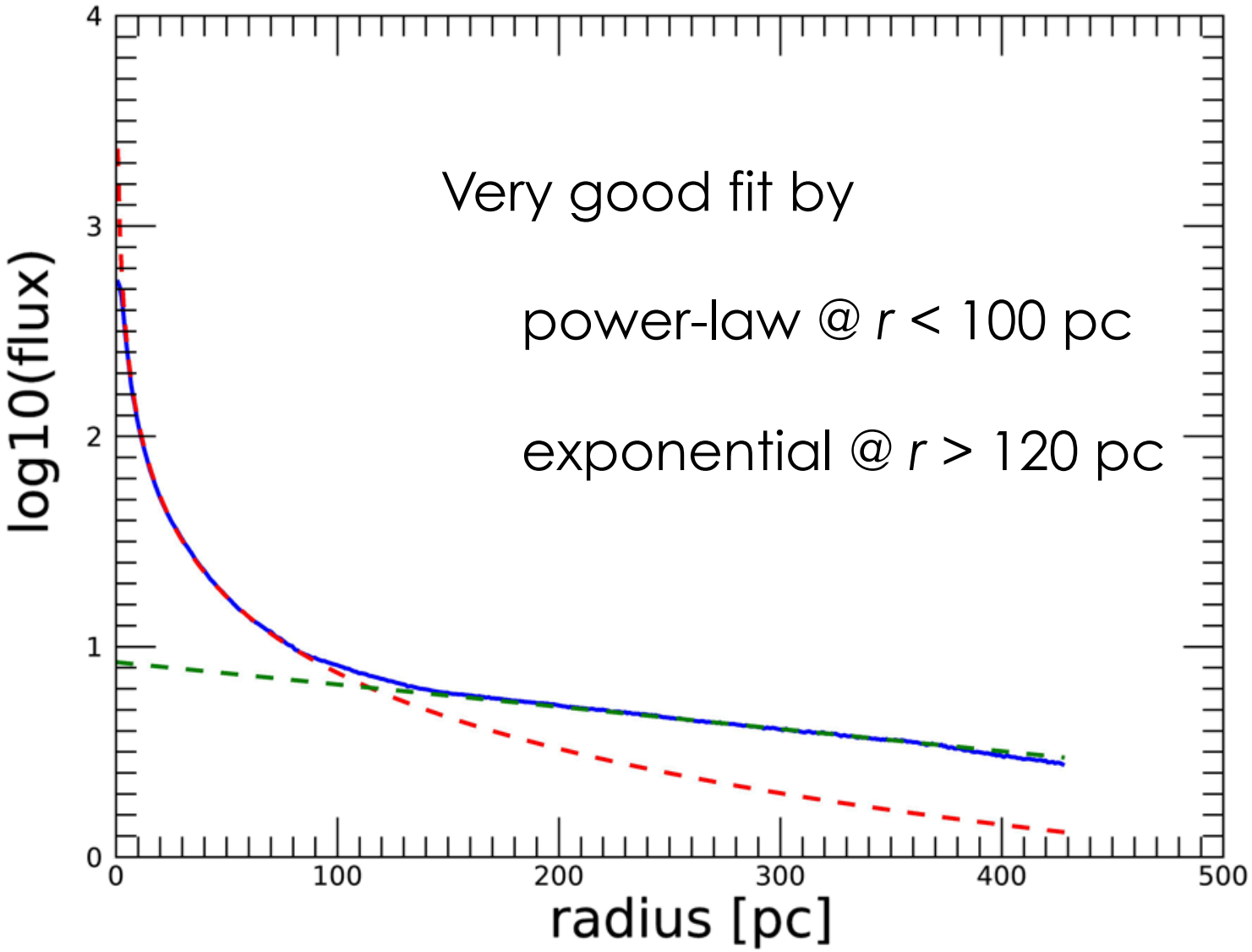
SPHERE polar H
(Gratadour+15)



Very bright central heart : structure ?



Radial median profile at H



Most internal radial profile @ H and K_s

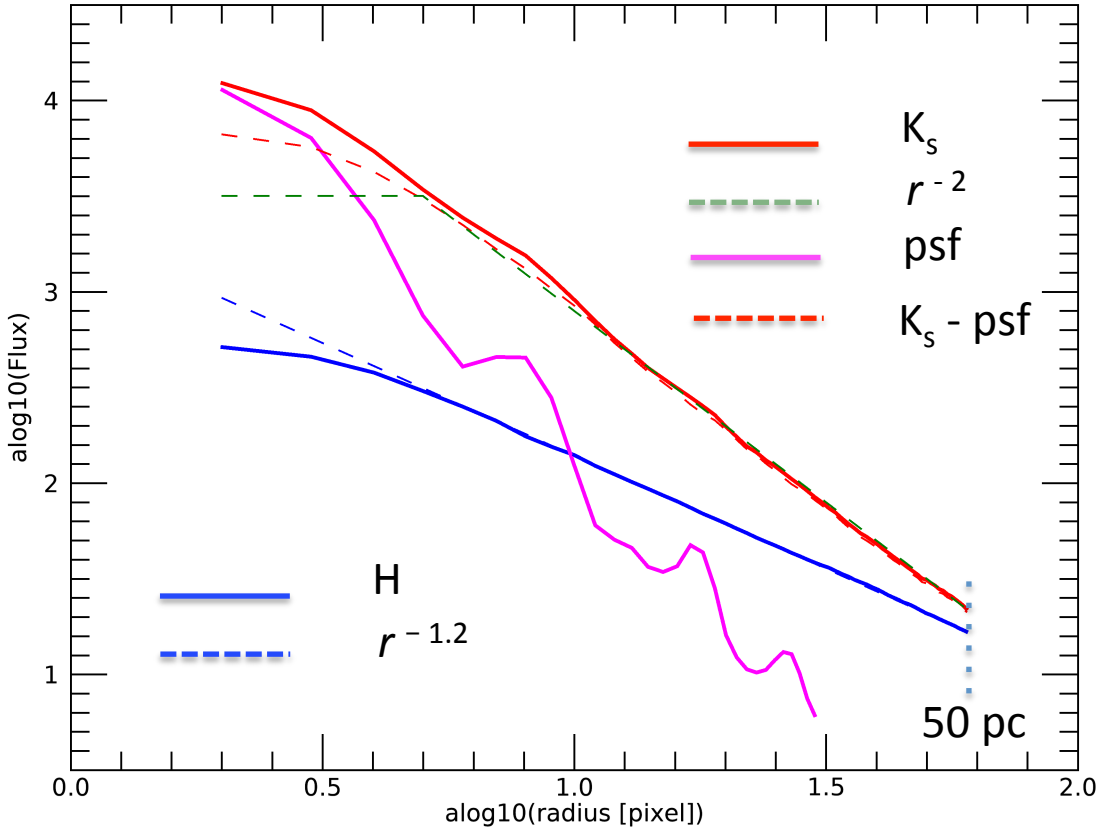
Very good fit by power-law:

$B_H \propto r^{-1.2}$

$B_K \propto psf + r^{-2}$

psf = dust core at 1400 K
= internal wall of torus

Power-law: cusp ?



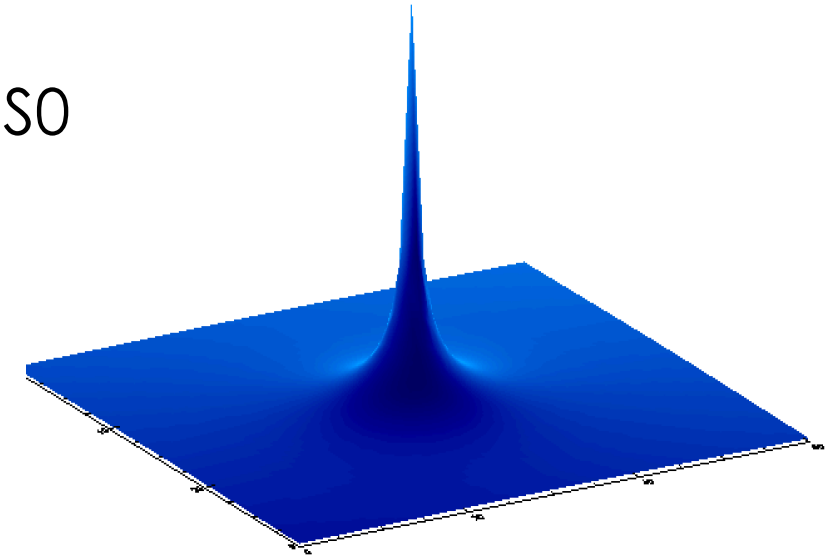
Cusp ?

Litterature : at least 3 types of *cusp* :

- Around a massive black hole : 2-bodies interactions
  $r^{-1.3\ -1.8}$
  but relaxation time too long

- Compact nuclear cluster
  current : 75% Scd ; 70% E - S0
  R : ~ 7 pc ; $r^{-0.6}$

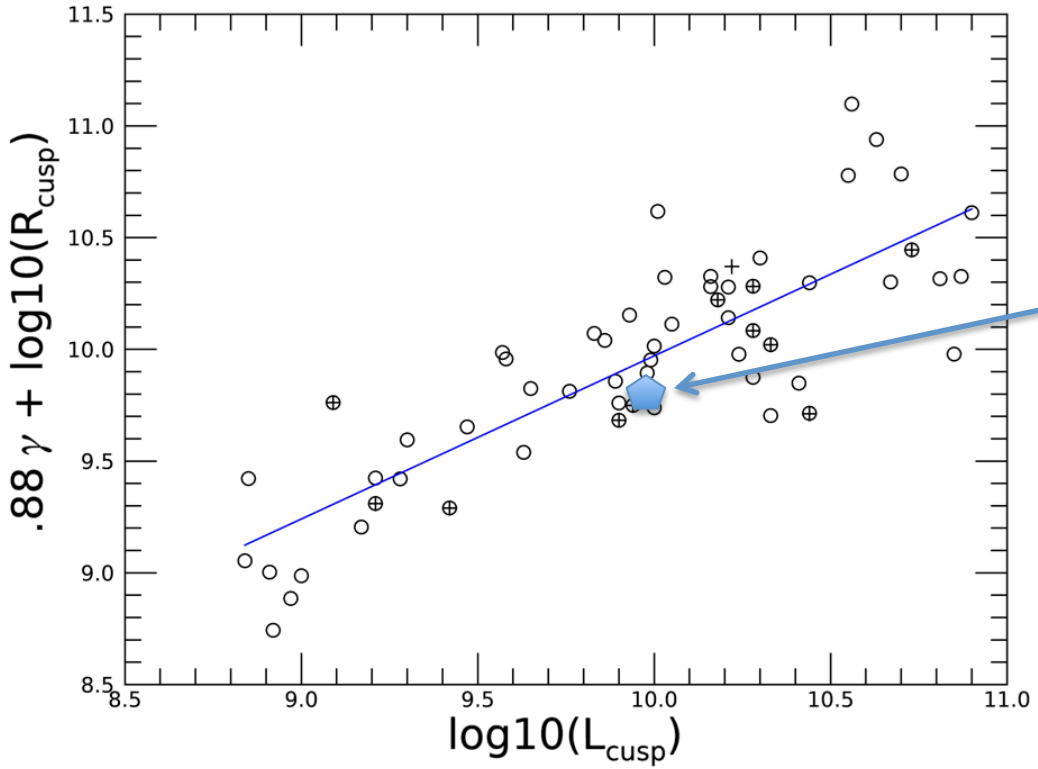
- **Central starburst cusp**
  R : 45 — 2400 pc $r^{-0.8}$



Starburst cusp ?

- Central starburst cusp : Haan+13

$$\gamma = 1.133 \times \left[\log 10(L_{\rm cusp}/R_{\rm cusp}) - 6.63\right]$$



NGC1068

Toy-model of radiative transfer

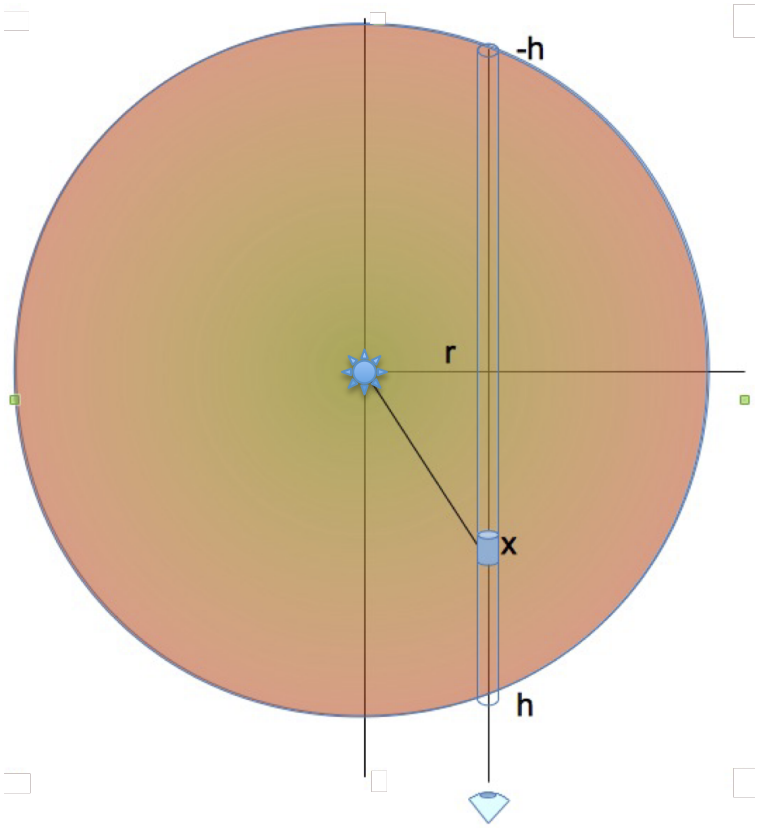
Simple model:

Sources :

- stellar cusp r^{-a}
- central engine
- hot/warm dust

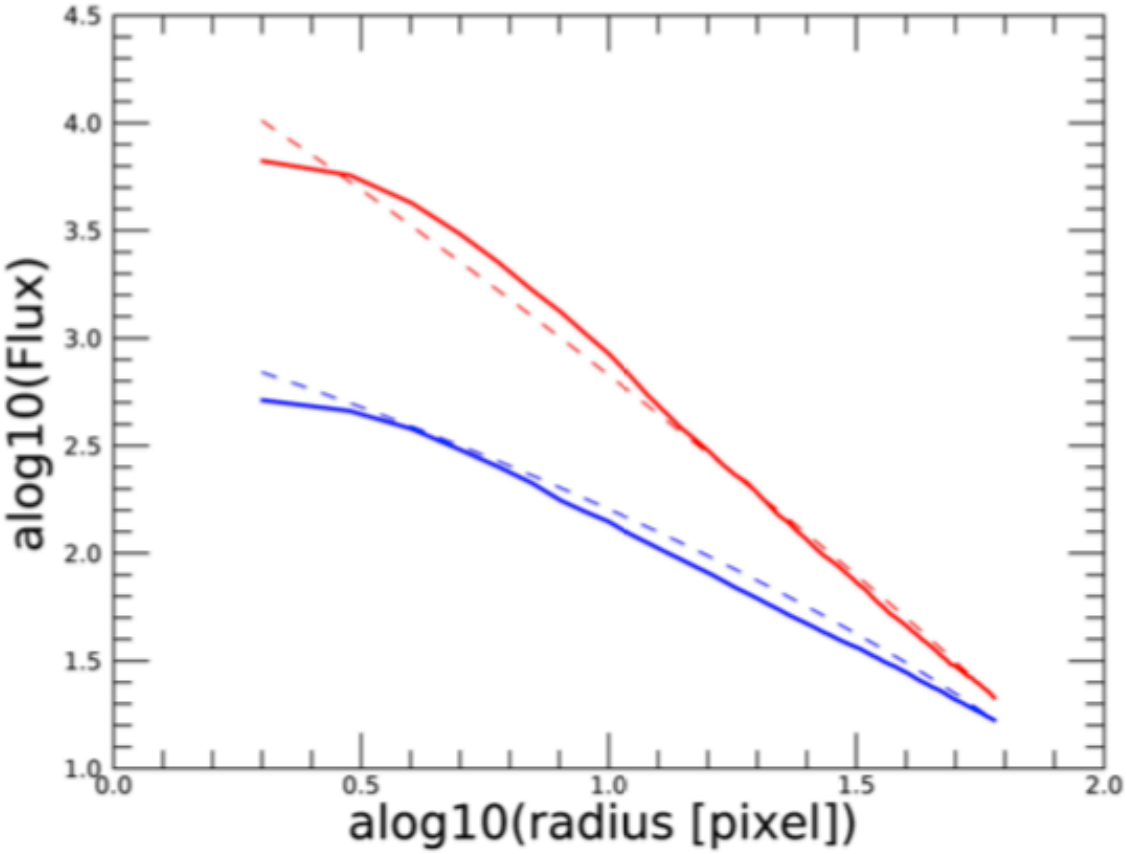
Absorber :

- dust distributed as r^{-g}



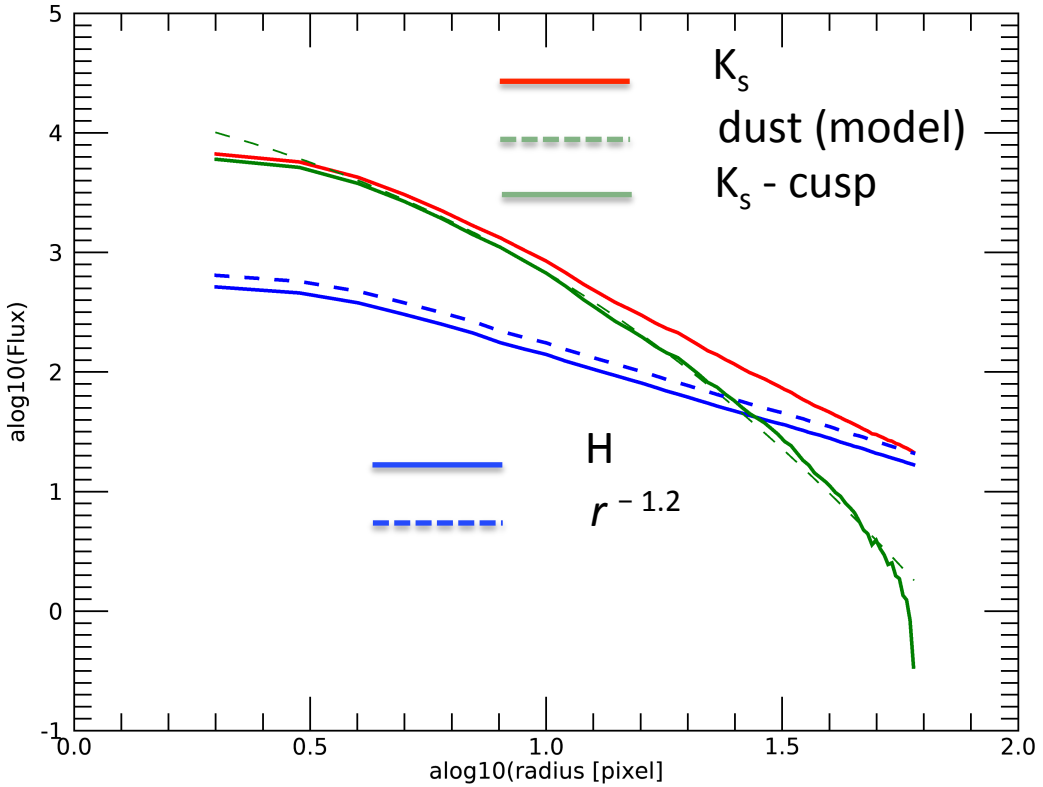
Pure stellar cusp ?

Differential extinction by a *cusp* of dust ?



NO : request too much dust and a stellar cusp with an unrealistic exponent ($\propto r^{-4}$)

Mix of cusp + warm dust ?



YES: thermal dust dominates at K_s @ r < 15 pc
$r^{-1.2}$ stellar cusp at H everywhere and at K @ r > 15 pc

Conclusion

Heart of NGC1068 : 3 components

- Stellar cusp $r^{-1.2}$, radius = 100 pc, L = 3.2 10^{10} $L_{\odot}$
  Probable remnant of a recent starburst episode
- Warm to hot dust heated by the C.E. on ≈15 pc
- Unresolved very hot dust (1400 K) implying un torus

Rouan, Grosset, Gratadour, A&A 2019 in press + arXiv:astroph

Question : is the pronounced cusp a tracer of dark matter halo ?